Space Weather Technical Forecast

Issued on Sunday, 01 May 2022 at 01:20 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: X-flare from AR2992 on 30th from over limb. Activity reducing, with decreasing chance of M-flares day 1 (1st). Slight chance G1-G2 Minor-Moderate Geomagnetic storms day 1 (1st).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been High with one X1.1 flare peaking 30/1347 UTC, and four M-class flares observed. These were all from ex-2994, which is just beyond the northwest limb, but with magnetic looping visible extended above the northwest horizon. There are four sunspot regions on the visible disc, however these are all relatively small and stable, with only AR2999 Cso/Beta exhibiting any sign of slow development. No Earth-directed CMEs have been observed in the last 24 hours.

Solar Wind / Geomagnetic Activity: The solar wind observed at L1 by DSCOVR, has been at slightly elevate to elevated speeds, at around 500 km/s, due the combined influence of the ongoing fast wind of coronal hole 78 and the arrival of a CME, which left the Sun on 27th April. Density was around average throughout, but with a brief period below average 30/0700-1100 UTC. The total Interplanetary Magnetic Field strength (Bt) was at peak value near 12nT at the start of the period, but declined to 5-7nT by 30/0700 UTC. The north-south component, Bz, reached a negative peak of -10nT also at the start of the period, but remained highly variable throughout, mainly between 5 and -5 nT from 30/0400 UTC. Phi angle was negative (towards the Sun) throughout. Geomagnetic activity was initially Active between 30/0000-0600 UTC (originally estimated as G1/Minor Storm 0300-0600 UTC but reassessed) and has been Quiet to Unsettled since.

Energetic Particles / Solar Radiation: The high energy proton flux (10 MeV) was only very slightly elevated above background, having declined since the recent slight increase due to the M1.1 flare on the 29th. The high energy electron flux (greater than 2MeV) soon dropped out from initially Moderate levels due to the CME arrival, and only recovered after 30/1200 UTC back to Moderate levels, peaking 836 pfu. The associated 24-hour fluence remained below the Active (1e8 integrated pfu) level, with 1.62e7 integrated pfu observed at 01/0000UTC

Four-Day Space Weather Forecast Summary

Solar Activity: Activity is expected to decline day (1st), but with a chance of persisting at Moderate levels with any further flaring from AR2994 from over the northwest limb. A returning to mainly Low to Very Low activity is then expected day 2 onward (2nd) but with a slight chance of further M-flares.

Solar Wind / Geomagnetic Activity: A CME from the M1.2 flare of ex-AR2996 on the 29th has the potential to give some glancing impacts at Earth on day 1 (1st), due to a passing shock. This is low confidence, however with the main plasma release clearly missing. Otherwise current slightly elevated to elevated winds are expected to persist day 1 (1st), before easing day 2 (2nd) onward with no further notable enhancements expected. Geomagnetic activity is forecast to be Quiet with Unsettled to Active intervals day 1 and day 2 (1st and 2nd), with a slight chance of isolated G1-G2 Minor to Moderate Storms day 1 (1st) should any CME influence be observed. Activity is then expected to decline to mainly Quiet with isolated Unsettled intervals day 3 (3rd)

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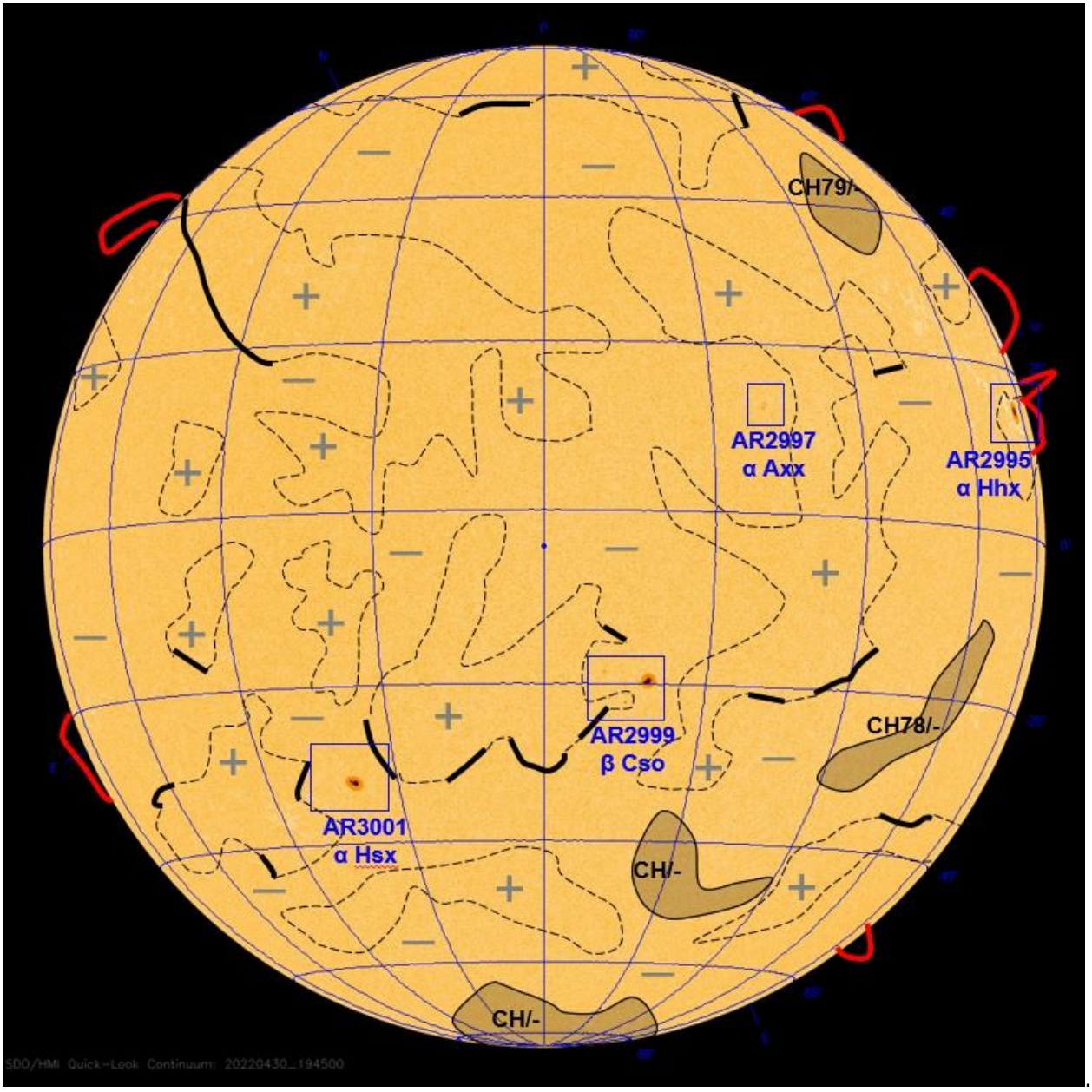
onward.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) is most likely to remain at background levels through the next four days. High energy electron flux (greater than 2 MeV) may be suppressed for a time day 1 (1st), but then likely increasing through the period with Moderate to High levels expected day 2 (2nd) onward. This will give a chance of the associated 24 hour fluence to rise above the Active (1e8 integrated pfu) threshold by day 3 (3rd)

Figure 1. Solar Analysis Valid 30/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A number of CMEs have been observed leaving the Sun in the last four days, however this are nearly all expected to miss Earth. The only potential exception is from the M1.2 and filament eruption from the plage of ex-2996 around 29/0830 UTC. The bulk of the plasma associated with this CME is also expected to miss the Earth, however a notable shock was observed which could have a potential Earth-directed component, and would pass during day 1 (1st) if it does. There is significant uncertainty to how much of an influence this will have if it does, however it does bring a slight chance of G1-G2 Minor to Moderate geomagnetic storms.

Otherwise the solar wind, currently at slightly elevated to elevated speeds due to the ongoing fast wind influence from CH78/-, is expected to only gradually ease towards background through the period. This likely declining day 2 (2nd) onward. No other coronal hole sourced enhancements are currently forecast.

Geomagnetic activity is forecast to be Quiet with Unsettled to Active intervals day 1 and day 2 (1st and 2nd), with a slight chance of isolated G1-G2 Minor to Moderate Storms day 1 (1st) should any CME influence be observed. Activity is then expected to decline to mainly Quiet with isolated Unsettled intervals day 3 (3rd) onward.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	20	5	1	1
Strong	G3	No	2	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Figure 2: Current observed Solar winds at L1

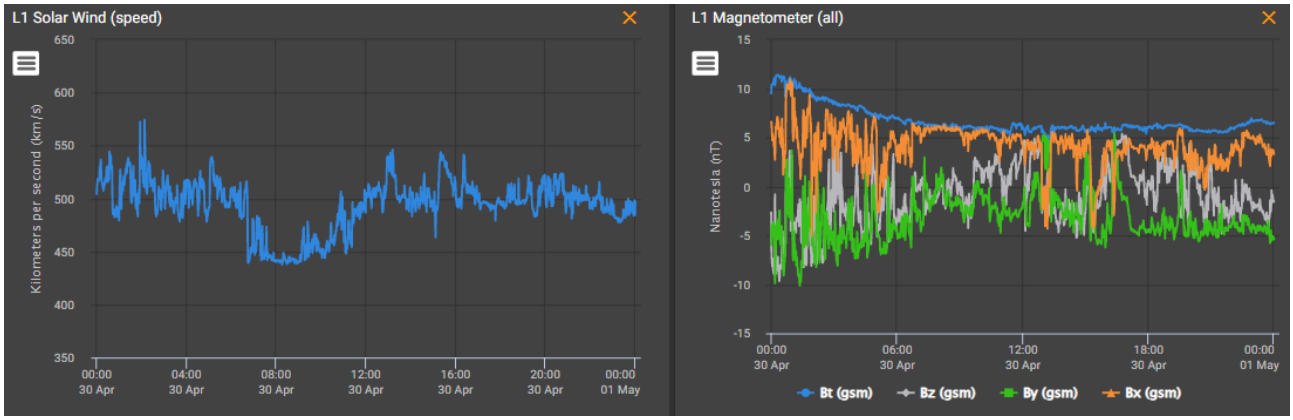

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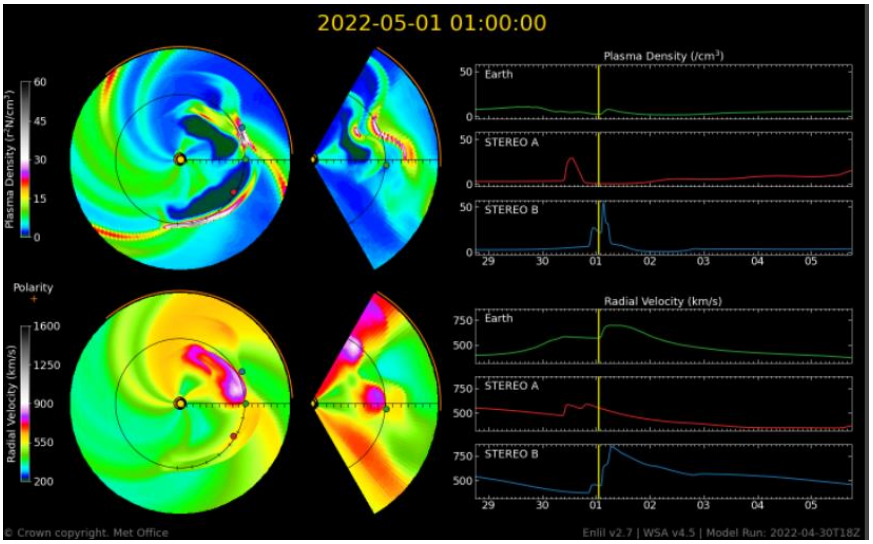
Figure 3: Enlil Forecast and Ensemble showing potential "worst" case with passing shock CME. However this is low confidence.



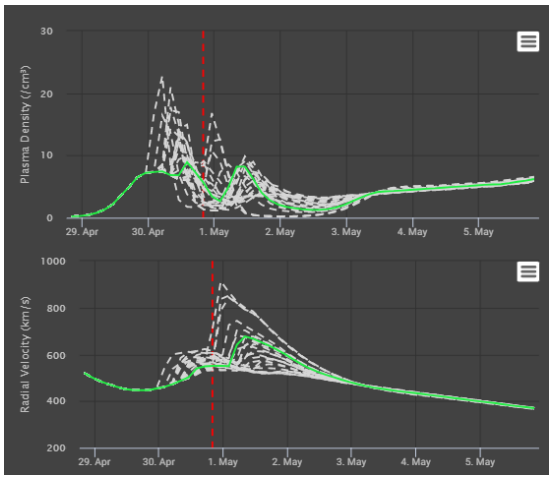
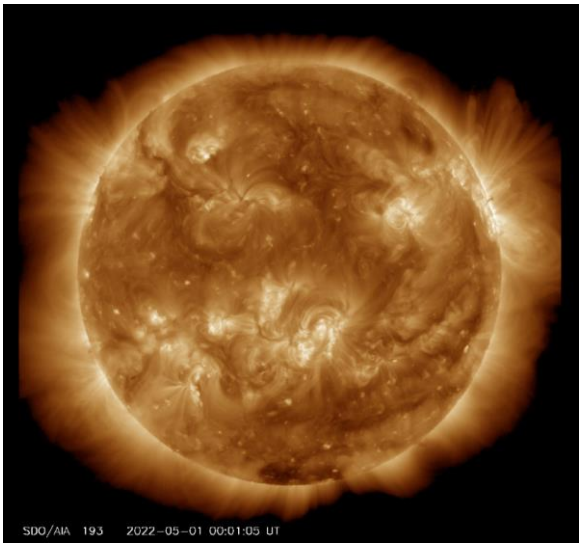


Figure 4: SDO aia-211 showing no significant CH expected for the forecast period.



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Radio Blackouts - X-Ray Flares:

Solar Activity is currently High due to an X1.1 flare from AR2994, from just over the northwest limb, peaking at 30/1347 UTC. This region also produced four M-class flares in the last 24 hours. There is a chance of further M-flares from this region on day 1 (1st), however as any magnetic looping associated with the region continues to rotate around the horizon, this risk will decrease.

There are four sunspot regions on the Earth-side of the Sun, however these are all smaller and simpler regions, and unlikely to be the source of notable flares. Two of the regions, AR2995 Hhx/alpha and AR3001 Hsx/alpha are stable mature regions, whilst AR2997 Axx/Alpha is now very small and decaying. The final region AR2999 Cso/Beta has shown some slow evolution of trailer regions, but no overall growth.

Overall, initially High activity has a chance of persisting at Moderate day 1 (1st), but likely falling to Low to Very Low day 2 onward (2nd). A potential returning region in the southeast (ex-2992) slightly increases the chance of M-flares by day 4 (4th).

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	30	5	5	10
Very Active	R3 to R5 X Class	Yes	1	1	1	1

Figure 5: GOES 16/17 X-ray Flux

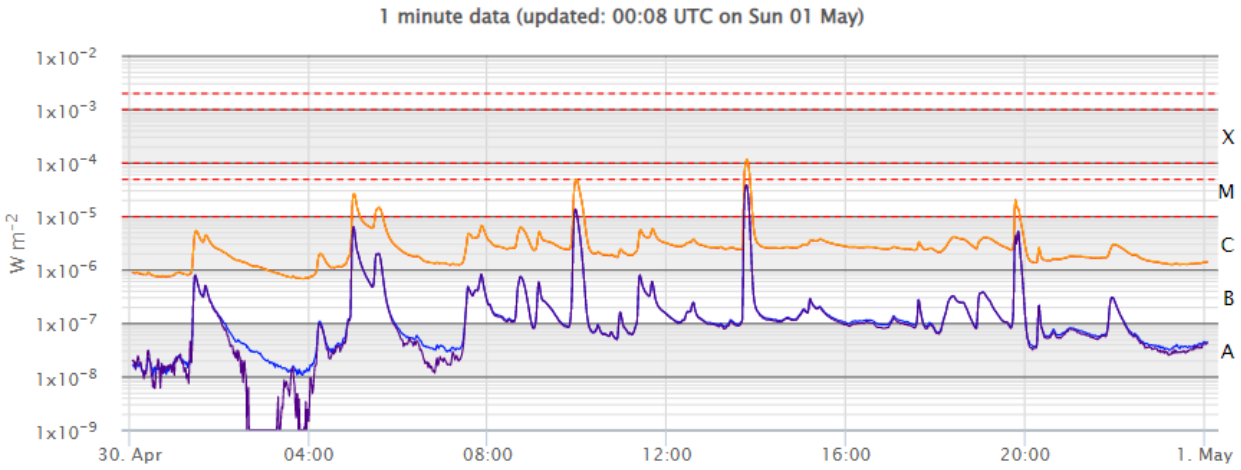

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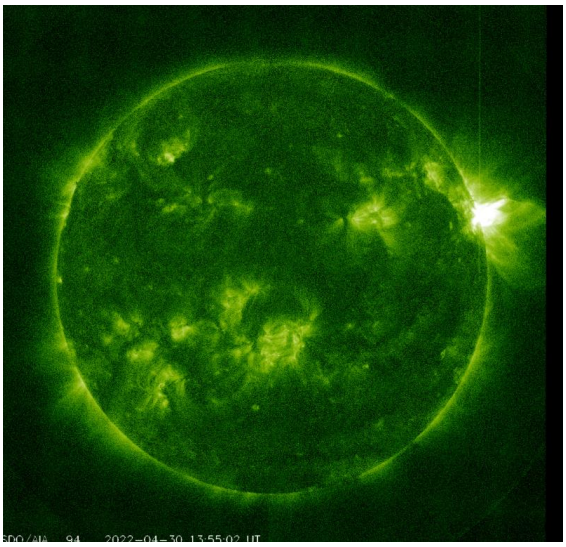
Figure 6: X1.1 flare of AR2994 over NW limb

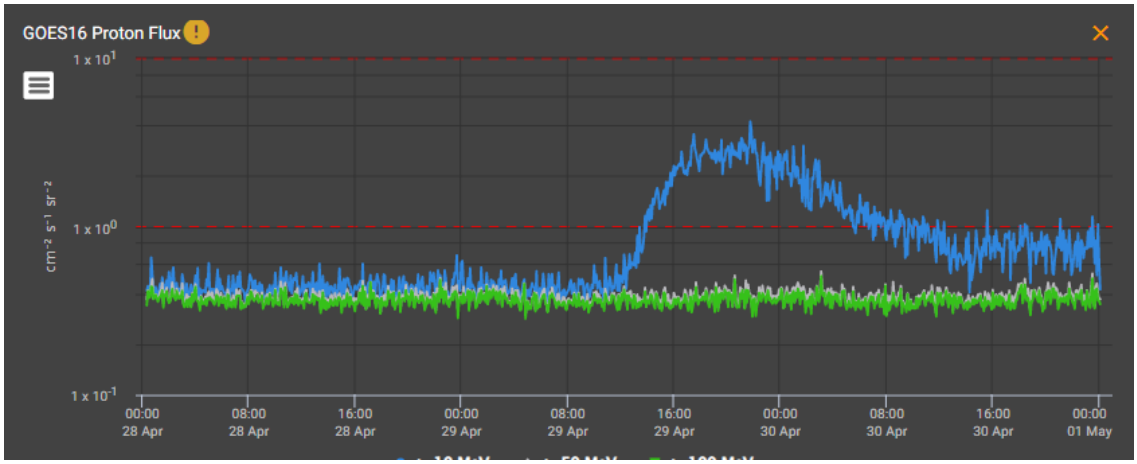


Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) as measured by GOES-16 at GEO is at background levels, and is most likely to remain so through the next four days. However AR2994, which is just over the horizon of the northwest limb, is still able to give a proton enhancement at Earth giving any energetic particle release from any further flaring of this region. This risk decreases by day 2 (2nd).

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	2	1	1	1
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 7: GOES-16 >10MeV Proton Flux during the last 3 days. 10pfu required for S1.



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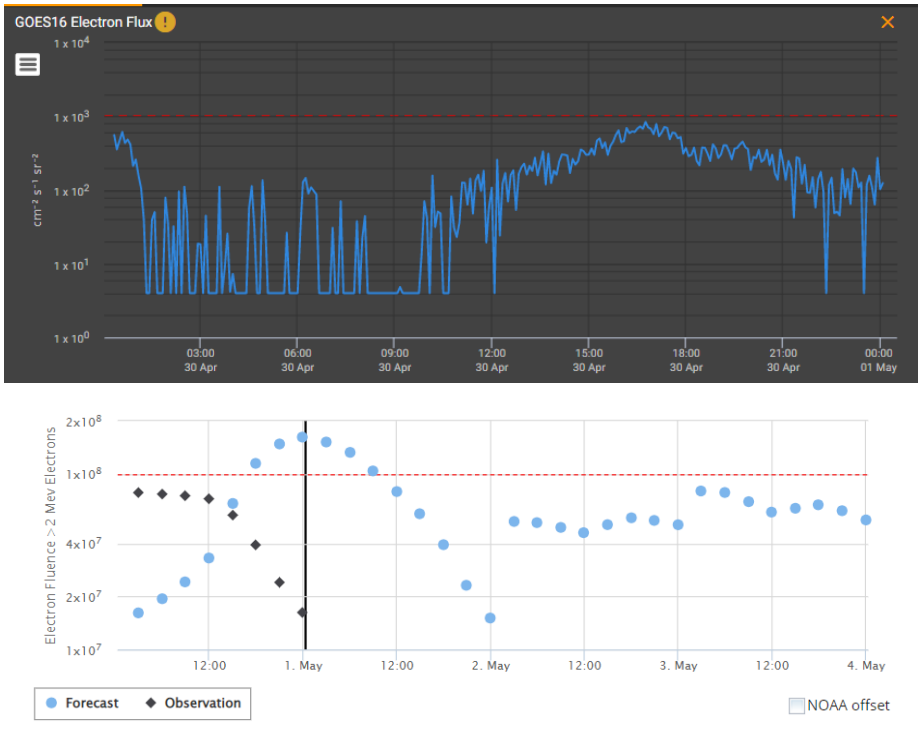
High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) as observed by GOES-16 at GEO is expected to see a day to day increase as solar wind pressure on the Van Allen belts eases. The belts have likely seen charging from the recent fast wind enhancement, with Moderate to High levels forecast late day 2 (2nd) onward. There is some uncertainty, however, with recent weak CME arrival and a further slight chance of a CME arrival on day 1 (1st), which could both have helped to clear out the electron content of the belts. There are no other potential sources of drop out or charging currently forecast.

The associated 24 hour fluence is expected to remain below the active (1e8 integrated pfu) threshold day 1, but with an increasing chance of rising above day 2 (2nd), and likely rising above days 3 and 4 (3rd and 4th). REFM is currently giving a mixed forecast, due to the model not taking account of the recent CME arrival, and hence the disparity in the short-term. However, it does have a suggestion of an increasing trend over the current value, once this influence subsides, and giving support to potentially reaching Active levels day 3 (3rd)

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	10	30	60	60
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 8: GOES-16 >2 MeV Electron Flux and associated Fluence with REFM.



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